

AMENDMENT NO. 1

May 25, 1943

TO ENGINEERING SPECIFICATION OF

CONTRACT BETWEEN THE

COMMISSION TECNICA Y FINANCIERA DE LAS CERCAS HIDROELECTRICAS

DEL RIO NEGRO (CHILE), CHILE

and

INTERNATIONAL CENTRAL ELECTRIC COMPANY, INCORPORATED

Dated Jan. 8, 1943

All references are to paragraphs and page of "Engineering Specifications."

1. Paragraph 3, page 3: Following the list of materials insert "Should the contractor propose to use any material with specifications differing from those of the American Society for Testing Materials, he shall first submit to the Consulting Engineer, for approval, a list of such materials, the specifications for the same, and the proposed use of, and stresses in these materials."

2. Paragraph 7, page 7: Change (a) voltage between phases, rated: Delete "7,000" and insert "11,500".

3. Paragraph 10, page 9, item (c): Delete "365 r.p.m." and insert "330 r.p.m."

4. Paragraph 10, page 9, item (e): Delete "7.9 in (approx.)" and insert "Sufficient to permit passage of the generator lower bearing brackets, but not less than 7.0 in."

5. Paragraph 11, page 11, item (e): 1st line: Delete "six inches" and insert "fourteen and one half inches."

6. Paragraph 16, page 17, item (b): Delete the first sentence and insert: "The contractor shall provide a heat exchanger to be located at an agreed location external of the bearing pit, and to have sufficient capacity to maintain the oil at the proper temperature with cooling water temperature at 25 degrees C. and with a minimum pressure of 20 pounds per square inch. All necessary piping, valves, fittings, pumps, motors, etc., for circulation of the oil through this exchanger shall be included."

All piping, fittings, valves, and exchanger tubes shall be of corrosion-resisting metals. The purchaser will supply and connect all water piping to expansion flanges supplied on the exchanger by the contractor.

7. Paragraph 16, last line, page 18. Delete the words "replacement".

8. Paragraph 18, page 19, item (b): Delete "Installation of the collars will be by the purchaser."

9. Paragraph 21, page 22, 5th line from top of page. Delete "at least 5/8 inch" and insert "not less than 1/2 inch nor more than 5/16 inch".

10. Paragraph 23, page 27. After "station-variety" and "subric" in the 1st line, insert "or Flange".

11. Paragraph 35, page 36. Delete the sentence starting in line 5 and insert the following: "This shall include the following: one jacking pump or lifting the rotating portions of the generator and turning by means of the braking cylinders, one set of jacking and wrenches with steel plate mounting board, one shaft lifting device with end ball to fit rotor, one set of eyebolts and landing-bolt stanch, one set of miscellaneous steel wire rope slings."

12. Paragraph 34, page 36:

- a. In item (1) change "Two" to "one".
- b. Delete items (2), (5), (6), and (7).
- c. In items (9) and (10) change "Two" to "one".

WITNESSED AND SUBMITTED

Signed By: Juan C. Serrano

WITNESSED AND SUBMITTED

Signed By: L. H. Haran

147-23-103

Haran Engineering Company
205 East Wacker Drive
Chicago, Illinois

RIONE

RIO NEGRO (URUGUAY) S.A. HYDROELECTRIC
DEVELOPMENT

CHICAGO 6, ILLINOIS

July 15, 1944

International General Electric Co., Inc.
570 Lexington Avenue
New York, New York

Gentlemen:

This will serve to confirm that the three addenda to the Engineering Specifications, (No. 1 dated May 28, 1943, No. 2 dated July 20, 1943 and No. 3 dated June 23, 1944) attached hereto, are part of the contract between the Comision Tecnica y Financiera de las Obras Hidroelectricas del Rio Negro (Rione), Uruguay and International General Electric Company, Incorporated, dated January 6, 1943.

Due to revisions called for in these three addenda, the final contract price shall be changed from \$1,327,527.00 to \$1,520,595.80 and the progress payments under Article 23 shall now read:

5% of the total purchase price, namely, the amount of \$21,029.75, within 20 days from the expiration of the payment period specified in Article 1, deducting from this amount what may have already been paid by virtue of the provisional order dated April 26, 1942 issued in favor of the Contractor.

15%, namely, the amount of \$43,009.32 after 25% of the work has been done.

30%, namely, the amount of \$45,115.10 after 50% of the work has been done.

50%, namely, the amount of \$45,115.10 after 75% of the work has been done.

100%, namely, the amount of \$1,520,595.80 upon delivery of the material for work or substitute delivery specified in Article 15.

- 2 -

10, namely, the amount of 102,359.55 after 12 months of successful operation in Uruguay but in any event within 24 months after the due date of the 30% payment.

It is also agreed that the time of delivery as specified in Article 13 of the Contract shall be changed to read October 30, 1944.

Yours very truly,

COMISION TECNICA Y FINANCIERA DE LAS
OBRAS ELECTROELECTRICAS DEL RIO NEGRO

BY _____

(Under Power of Attorney)

INTERNATIONAL GENERAL ELECTRIC CO., INC.

ACCEPTED

BY _____

Vice President

COPY

February 13, 1945

HE 02

Mr. L. F. Harza

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
5111 CHICAGO 6, ILL.
Steam Turbine - 2nd Unit

The undersigned was at S. Morgan Smith's Works on Friday, February 9th, and Saturday, February 10th, 1945 and the following is recorded.

Turner hub is ahead of schedule and coupling bolt holes had just been rough drilled.

Blades. Two blades were received about a week before, heats 5511-1 and 5511-2; each had grooves in the shank where slag had been cut out. The worse one of the two namely 5511-1 had been rough turned on the shank and the groove has been entirely removed. The shanks as received are about 23" diameter in the rough and are turned down to about 16" in rough machining.

Two further blades, heats 5647-3 and 4 had just arrived. The former has a groove about 2" deep in the shank, but there is every probability that it will cut out in the rough machining. As stated in Mr. King's report, the blades were accepted by S. Morgan Smith subject to being satisfactory after rough machining. Two further blades are yet to come.

Gates. Six gates were received some time ago and a further 6, had just arrived, and work on these will now commence. S. Morgan Smith stated that it was necessary to have 12 gates before commencing work to insure continuity of operation.

Blade Servo-motor Cyl. was stated to be through rough machining at Batchelor Co. Works and will be shipped to York immediately.

Servo-motor cylinders are due to be shipped in a few days from Florence Pipe Foundry. The cylinder heads are at York and work on these and the cylinders will commence as soon as the latter are received.

Governor Tank is welded up except welding the bottom dish to the drum.

Pit Liner. The majority of the plates have been cut out, but no welding done to date. The welding shop has almost completed a batch of gun mounts and it appears will now be in a position to make good progress on the pit liner, and catch

²
C O P Y

February 13, 1945

L. P. Harza
HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS

up on ~~Chicago~~ ^{Chicago} ~~lay~~ which has occurred in this item.

Progress Report. Graphical report marked up by Mr. King and dated February 10, 1945 is submitted herewith. This shows practically all items up to date or ahead of schedule, except pit liner.

cc: Juan C. Marzano -2

WAS:mas

By Robert A. Sutherland
R. A. Sutherland

HEOG

September 29, 1944

Harza Engineering Company
205 West Jackson Drive
Chicago 4, Illinois

Rhone Generator
Our Reg. I-41200

Gentlemen:

Attn: Mr. Erik Floor

My letter of September 2 outlined our plan for repairing the sand inclusion spots on the guide bearing face of the Rhone shaft. Since that time we have removed all of the metal from the three affected areas as shown on photographs which will be sent you. Careful inspection shows that we have reached sound steel at the bottoms of all of these areas. Our present proposal is to weld fill these depressions with low carbon electrodes, preheating the shaft, and peening each layer of weld.

We assume the same responsibility for the successful operation of this bearing, within the requirements of our Contract, as if these spots had not been present.

Yours very truly,

E. Henningsen, ENGINEER
MANAGER AND GENERAL ENGINEERING DIVISION

E. Henningsen:W

COPY

HE04

HARZA ENGINEERING COMPANY
CONSULTING ENGINEERS
CHICAGO 6, ILL.

Chicago, 6, Illinois
October 6, 1944

Mr. L. A. Cagno
The Negro Hydroelectric Development
205 West Wacker Drive
Chicago, Illinois

Re: Negro Project
Generator Shaft Forging

Dear Mr. Cagno:

With reference to our inspection trip to Schenectady, New York, on Friday, September 29th, please find attached hereto letters received from the General Electric Company and from the U. S. Engineer Inspector at that manufacturer's plant, together with photographs and sketch showing in detail the repair work on the lower generator guide bearing journal as completed to date.

From careful visual inspection of the areas in which were located the sand-inclusions, that have been removed by milling and grinding down to sound metal, it appears reasonably certain that no sand-inclusion areas of similar importance would be encountered in the completion of machining the shaft forging.

The General Electric Company's representatives tentatively agreed to repair the damaged areas of the journal by welding after pre-heating the entire forging to approximately 200° F., and sealing, peening, and inspecting each layer of welding material before placing the next layer on top of it (the approximate thickness of each layer being 1/4 inch). It is proposed to continue this procedure until the entire milled area has been suitably filled, to provide a smooth bearing surface after completion of the final machining.

Tests of the proposed welding rod materials had been completed by the General Electric Company at the time of inspection, and it was decided to use a carbon steel having a Brinell hardness of 150 to 153, as compared with the Brinell hardness of 172 to 174 of the shaft forging.

The following facts were considered in determining the remedial measures to be adopted:

- (1) The best delivery obtainable on a new forging is four months, as quoted by General Electric Company, to which nine weeks have to be added for machining time to bring the new shaft to the same state of progress as the present shaft, thus delaying shipment of the shaft to the S. Morgan Smith Company, for final alignment check with the turbine shaft, by approximately 6 1/2 months, or to approximately April 15, 1945.

10/8/51

COPY

- (2) The present guide bearing journal has a total bearing surface area of approximately 2500 square inches, of which approximately 60 square inches, or about 2.4%, is damaged. As a comparison, it should be noted that the upper generator guide bearing area is only 1200 square inches.

Yours very truly,

Matheson

Chief Engineer

November 10, 1944

Mr. L. F. Harza

From: R. A. Sutherland

Subject: RIOME TURBINES

HE03

The undersigned was at S. Morgan Smith Company's plant on November 9, 1944, and the following notes were recorded:

PROGRESS: Was inspected but is not reported in detail as the graphical progress chart adequately covers this. The generator shaft arrived during my visit. Mr. Officer and Mr. Rosebach of the Bethlehem Steel Company inspected the blade servo-motor casting and pronounced it very good. Pressure testing was deferred so as to use the adapter, which was not quite ready.

PERCENT ALLOWANCE FOR SHOP ERECTION: Mr. King said he allowed roughly 25% for parts which are handled or adjusted to a considerable extent during erection, and about 5% for parts which are handled only to a slight extent.

CHIPPING OF VANES: A drawing of suggested template has been prepared and two copies were brought. Two more will be forwarded by S. Morgan Smith Company, also a letter explaining in detail the reasons for chipping. S. Morgan Smith are not in favor of any sharp edged chipping. The methods of chipping were discussed, and Mr. Jessop warned against attempting to burn the excess metal off with a torch because he has seen castings seriously damaged by such procedure on account of the existence and sudden release of "locked up stress". It was suggested that the work could be facilitated by line drilling, leaving only small webs between the holes which could be chipped off, or possibly burned if done with care.

GROUT HOLES: This subject was fully discussed and it was agreed, subject to your approval, to use in the throat middle flange 12 holes 3" in diameter, with an additional 2 holes 3/4" in diameter in the last pocket to be filled, for release of air. The holes would be drilled on a slight slope, just sufficient to allow the drilling machine spindle to clear the top or bottom flange. In the bottom plate, 26 holes would be drilled at approximately 9 ft. 1 in. radius from centerline, and 3 in. in diameter. These holes would be closed off by plates 1" thick, and provided with bevelled edges for welding in place. Each plate would be provided with a hole tapped for 1/2 in. gas size plug, which would serve as a means of handling the plate and also for pressure grouting each pocket. The excess plate and plug to be ground off in the field on completion. The welding of joints at top and bottom of throat, on the complete periphery, was agreed to without extra cost. On account of the weld being continuous, it was agreed that the bottom weld would be 3/8" to 1/2" vee, and the upper weld 1/2" vee, both instead of the 5/8" suggested for the discontinuous weld.

The above information was conveyed to you. Mr. Jessop started draftsmen detailing the above immediately and the work on the throat flange can start immediately approval is received. The work on the bottom plate will be done as soon as it is free from the erection set-up. It was agreed that S. Morgan Smith should have some latitude in the

November 10, 1944.

positioning of holes to suit shop facilities. Weld rods for the above to be supplied by Rione. S. Morgan Smith use generally Murex E6020 or E6030, but I learned from shop men that they much prefer weld rod of the same designation made by the McKay Chain Company, York, Pennsylvania, as the Murex rods give off objectionable vapor. S. Morgan Smith will supply anchor straps for the upper part of the throat, at about 2 ft. centers, about 8 in. long, 2 in. wide by $3/8$ in. thick, with bent ends, and are willing to weld same on, but it is suggested they be shipped loose and field welded as they would likely be damaged in transit. The throat drilling and bevelling will involve no delay, and it was not believed the bottom plate work would involve any delay, as it will be done while other parts are being prepared for shipping. Mr. Jessop agreed that grouting of the throat ring should be done before the bottom plate is finally placed in position, and that the grout should be well worked down. He cautioned against careless use of pneumatic hammers on the throat ring to work the grout down.

GOVERNOR PRESSURE TANK: This was being painted inside and will be pressure tested with water. Mr. Lewis King suggested that the final finish coat of paint on the outside be deferred until field erection, as it will be impossible to handle the tank during shipping in the upright position, and the use of slings, even over lagging, will damage the paint. If this is approved by Rione and agreed to by S. Morgan Smith, a small rebate in price might be in order.

TILT OF SPEED RING - 2ND UNIT: This was discussed at considerable length in two parts, (1) effect on pit liner and (2) effect on turbine. Re (1), it was agreed that subject to approval, the bottom flange would be machined a slight bevel to compensate for slope of speed ring flange. Their pit liner drawings will be revised to take care of this, also the slight difference between theoretical and mean field elevation of the flange, and re-submitted for approval. There is ample margin on the seatings for thrust bearing and generator stator to allow for a small adjustment in the location of these parts. As the height of liner is roughly equal to the diameter, any correction would be of the same order as the tilt, namely, about $3/16$ inch or so. If approved, this procedure will allow pit liner work to proceed with no further field check or delay. Re (2), the tilt of Platinas 3 and 4 is regarded as a serious amount, being in fact about 8 times the maximum tolerance to which they usually work of $1/1000$ inch per foot of diameter. It was stated by Mr. Jessop and Mr. A. G. Smith, their chief erector, that it would be totally unsatisfactory to attempt to erect the turbine without correcting for the tilt. To do so would mean working to a tight wire (on a slope) instead of using a plumb bob and bevel and would lead to endless complication. At the same time it was agreed that it was not feasible to rig up a field method of truing the flanges in place. It is believed that the preferred procedure is to machine the seating flanges only of top and bottom plates on a bevel to correct for the field error, and to machine all other parts correct to the bottom face of the top plate, and the top face of bottom plate (these faces, as erected, would be horizontal). S. Morgan Smith also prefer to have their own erector make his own measurements immediately he arrives there in February, and send them to the shop, so that the work can be laid out to suit. It was stated that this will cause no delay, as it means deferring only the machining of the seating flanges until the measure-

*See memo to Rione dated
12/1/44 for S.M.S. letter
re: throat*

November 10, 1944.

ments are received, even assuming that they are ready to machine these parts by the middle of February.

Mr. Cagno's phoned statement that the rings were concentric to the tilted axis was conveyed to S. Morgan Smith; also the height of pipe tunnel in pit liner being 1300 mm.

ERECTORS: Mr. A. G. Smith seriously suggests that Rione request a second erector be sent down, on account of the need of speed. He intimated that this suggestion was made unofficially by the W.P.B. On inquiry, he stated that he has two or more available men, and if requested would select the best man, who could be furnished at the same rate as for Mr. D. W. Lehr. He stated that Mr. Lehr is an exceptionally able erecting engineer.

SHIPPING: It appears highly probable that shipment can be effected somewhat earlier than the advised dates, but I found it impossible to obtain an exact statement due to the fact that shop erection involves frequently placing and removing a part or parts several times. It is suggested, however, that S. Morgan Smith be asked for an approximate packing list estimated as to cubage, weights, etc., and that tentative shipping arrangements be initiated so that no delay will occur due to transportation causes. I see no reason why the throat ring, gate servo-motor cylinders and some other parts could not be shipped ahead of the rest.

WHITWORTH THREADS: Although these threads can be cut on the lathe, it is impossible to obtain Whitworth gauges at the present time, and it is believed it would be unsatisfactory to cut the threads here. It was also believed by S. Morgan Smith that a verbal agreement was made that Whitworth threads be cut by Rione and it is suggested the request be reviewed.

SECOND UNIT SCHEDULE: It is highly desirable that a work schedule for the 2nd unit be arrived at. Mr. Lofft is working on this together with S. Morgan Smith Company's estimating department, and it is expected to have a tentative schedule within a week or so. When available, it is suggested that an endeavor be made to have same officially approved by the W.P.B. so that S. Morgan Smith will have this as an answer to local pressure on behalf of other work. Mr. McCormack indicated that such local pressure may become severe, since the existing W.P.B. directive on form M-293 merely directs S. Morgan Smith to have the work ready for shipment by September 1945.

TRANSMITTAL: In line with last report, two copies hereof are transmitted to Mr. Cagno as an official communication.

Robert A. Sutherland
Robert A. Sutherland

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE

835 U. S. POST OFFICE AND COURTHOUSE
P. O. BOX 1234
CINCINNATI 1, OHIO

15 March 1945

Karna Engine Works
275 West Madison Street
Chicago (6) Illinois

Attention: Mr. Robert A. Rutherford
Engineer

Enclosure

Inclosed is copy of report submitted by Mr. Robert E. Turner, U. S. Engineer Inspector stationed at A. B. Cook, Inc., Lawrenceburg, Indiana, and inspection report covering Pumps, Serial Nos. 6578 and 6579, also Test and Operation Sheets on same pump.

Reference is made to letter from this office dated 2 March 1945 in which it was stated that the porcelain bowls were not cracked at the time the pumps were shipped from Lawrenceburg. This statement is correct, however, there were small surface cracks on the guide vanes which were not considered sufficient cause for rejection and would not impair the efficiency or life of the pumps.

Mr. Kneeb, Supervising Inspector of this office visited A. B. Cook, Inc. on 6 March 1945 and examined similar Pump of same size and capacity that was ready for shipment on another Government order. He examined the cracks on the guide vanes and found that no surface cracks were larger than 1/8" and so small that there was no means of measuring the width of the crack. This is a typical job and comparable to the two pumps shipped to Rome.

FOR THE DISTRICT ENGINEER:

Very truly yours,

William F. Schipper

William F. Schipper
Captain, Corps of Engineers
Chief, Inspection Branch
Supply Division

3 Incls.

- #1 - Report R. E. Turner.
- #2 - Inspection Report, Ser. 6578, 6579.
- #3 - Test and Operation Sheets.

March 5, 1945

1

Subject: Rio Negro Project - Contract W4-11-ENG-4
Rione Sump Pumps

To: Captain William F. Schipper, Chief, Inspection Branch,
Supply Division, U. S. Engineer Office, Cincinnati, Ohio.

1. I have been a resident inspector for the U. S. Engineer Corps in the plant of A. B. Cook, Inc., at Lawrenceburg, Indiana, for slightly more than two years. I recall this subject contract, and my inspection report indicates it was completed on September 20, 1944.

2. It is my practice to inspect for the Government in this plant, rough casting, work in process, and finished products. I was on my vacation at the time you witnessed the test of the first unit completed on this order, but I witnessed the test of the second unit, as the inspection report to the Cincinnati Office will indicate.

3. I have examined the blueprints attached to your letter of March 2nd, and I do not believe the cracks in the bowl guide vanes were of a nature which would cause me to reject these parts as commercially unsound and unsuitable for acceptance by the U. S. Engineer Corps. A. B. Cook, Inc. operates its own foundry, and I have always found that the attitude of the Company has been to replace any castings about which there might be a question as to their soundness. On this job I remember specifically that one of the outlet case castings was not acceptable to me, and it was rejected and replaced.

4. You will find that in the process of porcelain enameling on pumps of this size, it is almost impossible to produce a casting where the bowl vane will not show some cracks after the casting has been fired for porcelain enameling. My inspection report indicates that some shrinkage cracks appeared in the bowl guide vanes, but I did not consider them sufficient cause for rejection.

5. Often in turbine bowls this fins appear in the water passages. This is caused by the iron penetrating the core. It is the practice to remove these fins where practicable, but sometimes the curvature of the bowl vane is such that at certain places in the bowl the fins cannot be removed.

6. These fins must be removed before the bowl is porcelain enameled. After it is porcelain enameled, it is not advisable to remove them.

7. In my opinion the fins would not be objectionable, because the pumps met the test specifications by your witness test and by mine. They would not in any way interfere with the operation of the pumps.

8. The stainless steel pump shafts used in these pumps were manufactured by Carpenter Steel Co. of Reading, Pennsylvania, and are of the standard stainless steel used by A. D. Cook, Inc. for this purpose. This shafting is purchased by A. D. Cook, Inc. to specification, as to diameter, as to chemical analysis, and as to straightness. This stainless steel is known as Carpenter No. 5, containing 12% to 15% chromium. I understand that this quality of stainless steel is the standard material used by most pump companies, unless a stainless containing 18% chromium and 8% nickel is specified. In my opinion this is not a poor quality of material.

9. The inlet case bearing for the pump shaft damaged was not, in my opinion, damaged by unskilled workmanship or improper handling. It might have been injured between the time it left this plant and the time it was delivered at the Rio Negro project, but my inspection report indicates these bearings were sound at the time the equipment was bored in the Cook plant.

Respectfully..

/s/ Robert E. Turner

Robert E. Turner
Inspector

de Cook

Bombas Cook - (a) De la información adjunta resulta que el esmaltado del bowl no es una práctica común, y algunas opiniones son decididamente contrarias a su empleo; hay opiniones contradictorias con respecto a las grietas en los álabes pero en general se admite que ellas ocurren en mayor o menor extensión, especialmente en bowls de grandes dimensiones como los nuestros. Harza Engineering Co. aconsejó el esmaltado, en nuestras bombas, por razones de mejor rendimiento; en aquel tiempo nadie observó, que yo sepa, (ni Harza Engineering Co. ni Cook Co.) que ese tratamiento tendría el inconveniente de que se trata. - Posiblemente las grietas constatadas en las bombas de Rione no son debidas exclusivamente al proceso de esmaltado en si, sino al concurso de una calidad inadecuada de la fundición, como lo sugiere alguno de los consultados.

En resumen, creo que en el caso de grietas como las constatadas allí (según informes y croquis remitidos por Ud.) que afectan todo el espesor de los álabes, en una gran extensión, corresponde el rechazo de los bowls.

(b) En lo que respecta a la rectitud del eje la opinión general entre los que realmente tienen experiencia con ese material, es que es difícil (algunos dicen que es casi imposible) obtener ejes rectos de stainless steel y esta opinión ha sido confirmada en conversaciones con otros ingenieros que no figuran en la información que se adjunta. Además esas piezas deben ser manejadas con sumo cuidado para que no sufran deformaciones, durante su transporte y montaje.

Harza Engineering indica una tolerancia de 5/1000 per ft.; pero hago notar que la fábrica ya estableció, en el informe cuya copia remití antes, que su standard es 8/1000 á 10/1000 per ft.; como las especificaciones no establecen limitación alguna al respecto y puesto que debe sobreentenderse que se entendió comprar un equipo standard de la fábrica, las tolerancias que valen son las standard del fabricante es decir 8/1000 á 10/1000 per ft. Cabe indicar aquí que la fábrica Cook, tiene una excelente reputación en U.S.A.

(Nótase que no es práctica común hacer todo el eje de stainless steel, sino unicamente la parte correspondiente al impeledor.)

Con la información remitida desde esa no se ve claramente si corresponde o no hacer una reclamación. Una información más completa y concreta respecto de la importancia de esas deformaciones, es necesaria; una información que muestre que realmente se trata de un defecto que afectará el funcionamiento ó la vida de la bomba.

(c) Considero no corresponde hacer reclamación alguna por las otras partes de la bomba puesto que no se trata de defectos que afecten el funcionamiento o la vida de la bomba sino de imperfecciones que consideranse propias de la fabricación standard comercial especialmente en el momento actual.

En resumen, por lo que desde aquí puede apreciarse, parece injustificable un reclamo de reposición de la bomba completa. Parece, en vez, justificado un reclamo de reposición de ambos bowls. No tenemos información suficiente para justificar un reclamo por el eje.

Por lo expuesto, propongo se plantee un reclamo formal de reposición de los bowls para lo cual, ruego me envíe toda información complementaria que pueda servir para dar a la fábrica una impresión exacta y concreta de la importancia de los defectos constatados (Confirmar que todas las grietas indicadas en el croquis oportunamente remitido son grietas en la fundición y no en la porcelana solamente o en caso contrario indicar la extensión de las grietas pasantes; adjuntar fotografías; toda otra información que pueda ser útil para el fin indicado).

El hecho de que las bombas fueron aceptadas por los inspectores y por Harza Engineering (a sabiendas de la existencia de las grietas, los primeros) debilita la posición de la Rione. Por otra parte, la reconocida seriedad y responsabilidad de Cook Co. permite esperar que si se presenta una reclamación debidamente fundada que de a la fábrica la evidencia de la calidad de inaceptables de los bowls, estos serán repuestos sin más discusión.

DRAFT

Mr. J. M. C. Neill
Rio Negro Hydroelectric Development
805 West Wacker Drive
Chicago 6, Illinois

March 21, 1945

Re: A. D. Cook Sump Pumps
Serial Nos. 6578 and 6579

Dear Mr. Neill:

This report covers the structures found faulty in the above pumps, as noted in your memorandum of February 24, 1945 entitled "The A. D. Cook Sump Pumps - Report from McIntire's Offices", and your letter of March 19, 1945 headed "The A. D. Cook Sump Pumps".

The contract provisions for guarding against or rectifying defects are briefly summarized for ready reference as follows:

"Article 15 provides for inspection by U. S. Engineers and that "the Purchaser may reject equipment..... as advised by the inspectors".

Article 17 provides that inspection as above does not exclude the responsibility specified in Art. 26.

Article 26 (a) The Contractor declares and warrants that (1) material and workmanship shall be first-class in every detail.

(b) The Contractor shall..... repair or replace f.a.s. New York upon the written request of the Purchaser by..... parts..... (1) which does not comply with the..... representative's..... herein established; (2)..... may be of..... defective design; (3)..... may show defects of workmanship or material within..... 12 months from the date on which the equipment was placed in commercial operation.

If requested by Contractor, the Purchaser shall return any defective parts to the Contractor's factory, freight collect, for inspection."

It is clear that inspection or approval by the U. S. Engineer Inspector does not waive any rights of rejection, and it remains only to determine whether the defects noted by Elmer are such that the pumps are not "first class in every detail" as required by Art. 26(a).

Inquiries were made of pump manufacturers, users and experts, with a view to determining generally accepted standards of quality, and pertinent information is appended and may be briefly summarized as follows, following the subdivisions of your memorandum:

(a) Bowls.

U. S. Engineer Inspector

Shrinkage crack appeared in base of the bowl guide vane, not considered sufficient cause for rejection.

Worthington Pump Company

Cracks may occur in enameled bowls and this company does not recommend same.

Fairbanks Morse Company

Only minor cracking should occur.

Chicago Subway Commission

Have 4 Cook pumps with enameled bowls which had no cracks when purchased and have operated perfectly.

Illinois State Water Survey

Have had several opportunities to inspect enamel bowls and in no case were they cracked. Mr. Ellis, however, indicated that the cast iron situation in the last year had not been satisfactory.

University of Illinois, Dept. of Ceramic Engineering.

There is no reason why porcelain enamel cannot be applied without cracking.

Peapack Pump Company

Hair cracks occur in porcelain. Never had a vane crack.

It is our conclusion that cracking of the metal is not inherent in the enameling process and that the cracks noted by Kline are reasonable cause for rejection of the bowls, even though they were passed by the U. S. Engineer inspector. The maker's claim that "cracks along the guide vane within the bowl..... cannot be prevented" (their letter of Feb. 16, 1945), would have more merit if the probability of cracks had been mentioned in their bid.

(b) Pores and fine in bowl casting

Small voids in non-stressed iron or semi-steel castings are quite usual and permissible, and are not believed adequate cause for rejection, unless they had to show to extend the casting or extend across more than one-third of the flange face. The thin fine in the water passages are likewise not believed detrimental, since the efficiency tests of the pumps were satisfactory.

(a) Shaft Rusting

The shafts were specified and claimed by the maker to be 12-15% chromium stainless steel and are also so stated by the U. S. Engineer inspector. A sample can be obtained for chemical analysis by Kline by drilling a small hole in the end of the shaft length or length in question. If the chromium is substantially less than 12%, the Kline have cause for rejection. It is to be noted that "stainless" is a relative term. The "Materials Handbook" 1944 edition states "low chromium steels are not 'stainless', the minimum for this purpose being 12%." Hence the chemical composition and not the presence of some rusting should be the only criterion of acceptability, since the makers warranted a certain minimum chromium content and did not warrant that the shaft would never rust.

(d) Damage to shaft and guide bearing.

It is impossible without further information to form an opinion as to whether the damage mentioned is such as to render the pump unserviceable. The U. S. Engineer Inspector states that the bearings were sound when shipped.

Your letter of March 19, 1945, 2nd paragraph, - Undulations in Shaft:

Bliss and Laughlin: No published standards of straightness for carbon steel shafts, allowance about 3 to 5 thousandths per foot; stainless steel hard to get straight - should be carefully handled.

LaSalle Steel Company: General allowance for carbon steel about 1/1000 inch per foot.

Republic Steel Corporation: Cold drawn stainless may not be straight. Ground and polished should be true. No reason why stainless should be worse than carbon steel.

Rustless Iron & Steel Corporation: Danger of distortion in shipment; tolerance should be about 1/1000 inch per foot; supply ground and polished shafting for pumps.

While the information is somewhat conflicting, it is recognized that it is more difficult to obtain straightness in a stainless steel shaft than in a carbon steel shaft. The tolerance of 1/1000 inch per foot is quite readily obtainable in carbon steel shafting, and the greatest tolerance allowed is 5/1000 inch per foot. It would be our estimate that a stainless steel shaft should not exceed the latter tolerance, and it is suggested that the undulations be carefully measured, using a long lathe bed as a datum.

Other Inquiries: Several other inquiries have been made, with negative results which there is no point in reporting herein. In particular the TVA have no porcelain lined pumps. The Reclamation Bureau reply has not yet been received.

RECOMMENDATION:

Bowls: It is believed that a sound claim exists for replacement of the bowls on the ground of substantial cracks in the metal of the bases, and we recommend that the Rione make written request of A. D. Cook for replacement of the bowls in terms of Art. 26. The bowls can be returned freight collect if the makers so request, and resort may be had to arbitration in accordance with Art. 30 in case of refusal.

*See between
1st & 2nd
pages to this* →
Shafts: If the measurements suggested show a deviation greater than 5/1000 inch per foot, it is believed that a claim would be justifiable but it must be recognized that the makers can counterclaim with poor handling at the other end. A report or affidavit demonstrating careful handling should therefore accompany such claim. The makers' packing list No. 6959 shows that the steel pipe and steel shafting were nested in 4 boxes for shipment, with gross weights each box of 1800 lbs. and net weight 3574 (or 1245, equal to 34% of the net weight, for boxing). This is believed to be well packed, judging from these figures.

Guide Bearings: We are not able with present information to recommend rejection of guide bearings, but such rejection should not be excluded.

Our inquiries show that A. D. Cook, Inc. have an excellent reputation and there is no reason to doubt that they will make good on a well founded claim.

Yours very truly,

L. P. Burns

By M. A. Sutherland
Acting Executive Assistant

RAS/ms

- Exhibits:
1. Letter from U.S. Engr. Office, Cincinnati, dated 3-2-45 and report by U.S. Engr. Inspector dated 3-5-45 with letter of transmittal from U.S. Engr. office, Cincinnati, dated 3-15-45.
 2. Letter from Dr. A. M. Burwell, State Water Survey, Illinois, dated 2-26-45.
 3. Letter from Prof. L. I. Andrews, Dept. of Ceramic Engineering, Univ. of Ill., dated 2-27-45.
 4. Memo of conversation with Dr. Larson and Mr. Millis dated 3-7-45.
 5. Phone memo Worthing Pump Co. and Elise and Laughlin dated 2-13-45.

Form 21, Insp. 1
7/27/43

NAVY DEPARTMENT
UNITED STATES ENGINEER OFFICE

Report of Inspection

Date September 20, 1944

Contract No. E-42-053-eng-4

Order No.

To:

(final)

1. The following (purchase) report of inspection on Two 24" Sump Pumps
Turbine type, with settings and accessories.
2. Contractor Harza Engineering Co. Address Chicago, Ill.
3. Manufactured by A. D. COOK, Inc. Inspected at Lawrenceburg, Ind.
4. Materials inspected (show item numbers of orders if any: Pumps, Serial #6378 and #6379
complete with settings and all accessories, except motors

5. Previous collections none

6. Contractor's request rec'd (date) continuous

Not inspection (date)

7. Inspection delay due to none

8. Inspection began 9-1-44

Inspection completed 9-14-44

9. Types and results of tests Laboratory test, show pumps to produce well above required
amount of output in both G.P.M. and head.

10. Materials were found to be in accordance with purchase order requirements with the following
exceptions: Shrinkage crack appeared in cover of the foot, gullivane not considered
sufficient cause for rejection

11. Parts List and Instruction Book Two with each unit

12. Material packed Export

13. Inspector's mark None used

14. Shipped to Where placed

15. Number inspected and approved to date Two complete sump pump units, less motors

16. Packing List, Inspection Report, B/L, forwarded to Consignee Sept. 20, 1944

17. Car No. NYC - 2003

Route N.Y.C.

(Date)

Commercial Police Permit No. 2003

18. Remarks Made general surface inspection; witnessed laboratory tests and checked
quantity of material shipped, witness test sheets attached.

19. Next shipment: Quantity Complete

Date Sept. 20, 1944

Robert E. Turner
Robert E. Turner

Chief, Inspection Section

Encl 2

of

Distances

SUMP PUMPS

Mr. Rezzano

Following notes by phone for your information:-

From Mr. Hermit: Worthington Pump Co.
400 W. Madison Ave.,
Franklin 1628

Cracks in Vanes:- Distortion of casting in enamelling process is hard to avoid. They supply enamelled bowls only under protest for this reason: Would reject if cracking is bad.

Shaft Rusting & Straightness:- They generally supply carbon steel shafts, alloy shafts now are generally emergency alloy. Suggested calling shaft supplier because supply of shafts for deep well pumps is a specialized business.

From Mr. Hartsburg: Bliss & Laughlin Co.
Commodore 1800

Shaft Straightness:- There are no published standards for straightness of shafts for deep well pumps. Their own trade practice is to "get as straight as possible", with the following ~~usual~~ allowances per 5 ft. length for 1020 steel 15/1000 inch
for 1030 steel 20 to 25/1000 inch

Stainless steel shafts are almost impossible to get straight and for this reason they have ceased supplying same. Shafts in 10 ft. lengths should always be carefully handled by 2 men lifting at third points.

Robert A. Sutherland
2-13-45

Mr. J. L. Schnitz

- 2 -

July 7, 1944

MEMORANDUM

TO: J.L. Schnitz
From: R.A. Sutherland
Subject: Sump Pump Test at A.D. Cook's Works
Lawrenceburg, Indiana

July 7, 1944

One of these two sump pumps was tested on July 6, 1944 and witnessed by the undersigned. The test set-up was as follows:

The pump was connected to a 12" pump head, and driven by a 150 hp motor mounted on a ball bearing stand with torque arm connected to a Toledo Weighing scale. Suction head was measured by a float gauge, and pressure head by a mercury manometer. Discharge was measured by a Baily flowmeter connected to a standard orifice, calibrated by the University of Wisconsin. The orifice had about 30 feet of straight pipe ahead of same to promote uniform flow. Speed was measured by a hand tachometer and stop watch. All measurements were observed and checked independently by the undersigned. On account of the factory being closed down for annual vacation, purchased power was used and the motor speed was approximately 1160 rpm instead of 1450 rpm, which is the specified running speed. Normally they use power from their own plant and can adjust speed to any requirement. The results were computed for 1450 rpm in accordance with the laws of homology, and are shown in attached test table and curve (red line). In accordance with standard allowances of the Hydraulic Institute, about 1 ft. head should be deducted from the head shown to allow for column water friction, and somewhat less than 1 hp added to the power to allow for shaft friction, with a reduction of efficiency of about 1% below that shown. This will still leave the performance appreciably better than guaranteed. In accordance with A.D. Cook's usual practice, no credit was taken for velocity head, which would amount to approximately 1 foot. In addition, the test was made with unpolished impeller and the polishing which A.D. Cook are going to do before shipment would increase the efficiency slightly.

The dimensional checking of individual parts was outside the province of the undersigned, but the pump bowl, impeller, section of shaft, bearings, some column sections, pump head, and flange valves were inspected and found to be workmanlike. It is therefore recommended that the pump be accepted.

The second pump will be ready for test in a week or ten days.

The following specific points are added for your information and attention:

To: J. L. Schnitz

- 2 -

To: J. L. Schnitz

July 7, 1944

July 7, 1944

Test of Second Unit. Will be ready for test in about 10 days. A.D. Cook Company would be glad to be informed if you wish to have this test witnessed also, or whether you wish the Government inspector to witness it.

Shipment. Both pumps will be ready for shipment in approximately 2 to 3 weeks. They will supply estimated weight and cubage or other information required on request from you.

Instructions. The undersigned took copies of 2 instruction tags which are attached to the pump as shipped, and a metal instruction plate fixed to the pump (with brass pins or screws). These have been handed to Mr. Cagno. It is suggested that these be duplicated in Spanish and sent to A.D. Cook for shipment. A copy of the text of setting-up and working instructions was also obtained and has been handed to Mr. Cagno. A.D. Cook have the material for 12 or 14 books of instructions ready to make up except for 1 large assembly drawing which had been sent out for reduction to a more handy size. It is suggested that they be informed promptly what disposition is to be made of these instruction books and the undersigned would suggest that either of the following course be followed:

- Anales...*
1. The text converted into Spanish and added to the text in English, one book to be shipped with each pump.
 2. The text to be left as is, but a notice in Spanish added to the 2 books shipped with the pumps saying "See Mr. De Anda before assembling pump".

As shipped, the impeller is in a certain relative position with regard to the bowl and the pump head adjustment is in a corresponding position. Adjustment is then made to allow for the stretch of shaft by hydraulic thrust: hence it is important that the adjustments be not altered by unauthorized persons.

Tools and Spare Parts. A special tool is needed for disassembling and subsequent assembling of impeller on shaft, and this is shown in detail on their drawing but not supplied. It is believed this tool could be readily made on the job, but if wanted as an extra, A.D. Cook should be informed in good time. If any spare bearing or other parts are required as extras, A.D. Cook should be contacted promptly on the subject. The undersigned would suggest that spare parts be obtained for 2 or 3 rubber gaskets which are used and that it might be advisable to obtain some spare shaft bearings and a spare ball bearing. A supply of "Keytight" gasket compound should also be shipped. The other gaskets

ok

Si loc. ok

To: J.L. Schnitz

MEMORANDUM
- 3 -

*Augue nos | ordeno
Oll. and lar con llaves de
Reino, unadeja,
July 7, 1944 de*

July 7, 1944 *Sroure*

can be cut on the job if spares are needed. They are made from N#19 Garlock 1/32" thick. It would be also advisable to send 2 special wrenches for tightening shafts, similar to the Walworth Parmelee pipe wrench which will grip the shaft without nicking by teeth. A stillson can be used but as the bearings have to be slid over the shaft, any nicks made must be filed smooth.

One of these two pump units was tested on July 6, 1944 and witnessed by the undersigned. The test set-up was as follows:

The pump was connected to a 12" pump head, and driven by a 150 hp motor mounted on a ball bearing stand with torque arm connected to a Toledo Weighing scale. Suction head was measured by a liquid gauge, and pressure head by a mercury manometer. Discharge was measured by a Daily flowmeter connected to a standard orifice, calibrated by the University of Wisconsin. The orifice had about 30 feet of straight pipe ahead of same to promote uniform flow. Speed was measured by a hand tachometer and stop watch. All measurements were observed and checked independently by the undersigned. On account of the RAS: hsl factory being closed down for annual vacation, purchased power - L. A. Cagno and the motor speed was approximately 1150 rpm instead of 1450 rpm, which is the specified running speed. Apparently they use power from their own plant and can adjust speed to any requirement. The results were accurate for 1450 rpm, in accordance with the latest homologs, and are shown in attached test table (red line). In accordance with standard allowances of the Hydraulic Institute, about 1 ft. head should be deducted from the head shown to allow for column water friction, and somewhat less than 1 hp added to the power to allow for shaft friction, with a reduction of efficiency of about 1% below that shown. This still still leaves the performance appreciably better than guaranteed. In accordance with A.D. Cook's usual practice, no credit was taken for velocity head, which would amount to approximately 1 foot. In addition, the test was made with unpolished impeller and the polishing which A.D. Cook are going to do before shipment would increase the efficiency slightly.

The dimensional checking of individual parts was outside the province of the undersigned, but the pump bowl, impeller, section of shaft, bearings, some column sections, pump head, and filter valves were inspected and found to be workmanlike. It is therefore recommended that the pump be accepted.

The second pump will be ready for test in a week or ten days.

The following specific points are added for your information and attention:

A.D. COOK

INCORPORATED
Manufacturers of



DEEP WELL TURBINES
PLUNGER PUMPS
EJECTOR PUMPS
WATER SYSTEMS
WELL STRAINERS
WATER WELL SUPPLIES

LAWRENCEBURG, INDIANA, U.S.A.
PHONE : LAWRENCEBURG - 6

February 16, 1945

Mr. L. F. Harza
Harza Engineering Co.,
205 W. Wacker Drive
Chicago 6, Illinois

Dear Sir:

I understand from Mr. Thomson of the Thomson Engineering Company at Chicago, that you received a wire dated February 10th, in regard to the pumps furnished on our order #69589 for Rione, Uruguay. The copy of the telegram has been divided into paragraphs, and we shall answer it accordingly.

1. The pump bowls were porcelain enameled, and if there are some cracks along the guide vane within the bowl, particularly at the discharge end of the bowl, they cannot be prevented, but they are not harmful to the quality of the material, nor to the service which the bowl will render in the pump.

The metal section of the vane itself is comparatively thin, while the internal and external sections of the bowl are comparatively thick. If you are familiar with the porcelain enameling process, you will understand that the bowl casting is fired in a furnace until it is cherry red, in order to fuse the enamel on the vane.

On large size pump bowls the shrinkage caused in the cooling process almost always causes the condition which you say exists. These bowls are within our specifications, and in our opinion are satisfactory.

2. These castings meet our inspection requirements. Because of the coring process it is impossible to make all castings free from voids. These voids are undoubtedly the result of the porcelain enameling process, because of reasons given under paragraph #1.

3. We are not concerned about the water passages, for the reason that these pumps were tested in our hydraulic laboratory, and performances were met. Any fins will not affect their field performance.

2/16/45

These fins are caused by the metal burning into the core. It is our practice to remove them as near as possible, and if any of the castings had fins in them, it was probably because they could not be removed by file or chisel. Since they do not affect the performance, there can be no objection to them.

4. We know definitely that the pump shafts furnished were 12-15 chrome stainless steel. Many times in the shipment of these pumps for export the outward appearance of the shaft where it is exposed might indicate a corroded condition. However, you will find, if you will make the commonly understood stainless steel test, that these shafts are 12-15 chrome, and any corrosion may be easily wiped off.

5. Our records do not indicate that any welding was done on any of the pump shafts, and you may be assured that if any welding was done, it was with a stainless steel material, and the pump shaft is as sound as if the welding had not been done. This company does not have a reputation of covering up anything on any of its products. Regardless of who purchases the product, it is not our intention to ship any part of it that is not acceptable for the service for which it is intended.

6. Pump shafts and line shafts are tested for straightness in our plant on ball bearing ways and indicated at the end, approximately 1' from the end, in the center, approximately 1' from the other end, and at the other end. Our tolerances are plus nothing minus two on the diameters, and straightness within .008 to .010 indicator reading in 10'.

We can assure you that these shafts are as good as can be purchased for the purpose, and they were indicated in our plant and were within these tolerances when they left our Assembly Department. You must realize that you are dealing with 12-15 chrome stainless steel material, that you have a water lubricated turbine, and you cannot expect to receive shafting that is much closer than the tolerances we have given you. Again we say that if we did not believe this material would meet good engineering practices, we would not have shipped it.

7. We would have to know what is meant by the bearing having deep cracks. You understand that the line shaft bearings in this case are only guide bearings for the shaft, and unless we knew the condition of the bearing, we would not know that it should not be used in the installation. However, we are of the opinion that since these bearings were inspected in the usual manner, it would be very unusual if a bearing was sent that would not be within our production limits.

2/16/45

8. We cannot accept the proposition of immediately furnishing replacement pumps without charge. It seems a bit unusual to us that you would take this position, inasmuch as the pumps were inspected by representatives from your office, by our own Inspection Department, and by a resident U.S. Engineer Corps inspector, at the time shipment was made. We can well understand that perhaps the representatives in Uruguay know nothing about A. D. Cook, Inc., but I am sure that the reputation of our company is such that we have no intention of furnishing you or any other customer a product that is not sound within good engineering specifications for the type of product.

You must remember that you are not purchasing a precision ground piece of equipment. You bought a pump to render you service, and A. D. Cook, Inc.'s standard of manufacture is as high, or higher, than most producers of turbine equipment.

9. We would authorize the operation of these pumps, but we think the operation of the pumps should be conducted on an engineering basis, and these pumps should be given the same operating treatment as they would if, according to your standards, they were sound. In other words, we believe there is some obligation on the part of Rione to operate these pumps in a thoroughly engineering, workman-like manner.

10. We have no comments to make with respect to this paragraph.

In writing the foregoing we would have it thoroughly understood that A. D. Cook, Inc. is not a firm to dodge any responsibility with regard to their products, regardless of their location. However, we believe that you have been shipped a good commercially sound product, and until we can be shown otherwise, we will not reorder the manufacture of these pumps.

Very truly yours,

A. D. COOK, Incorporated

BY: *Joe Downs*

Joe Downs

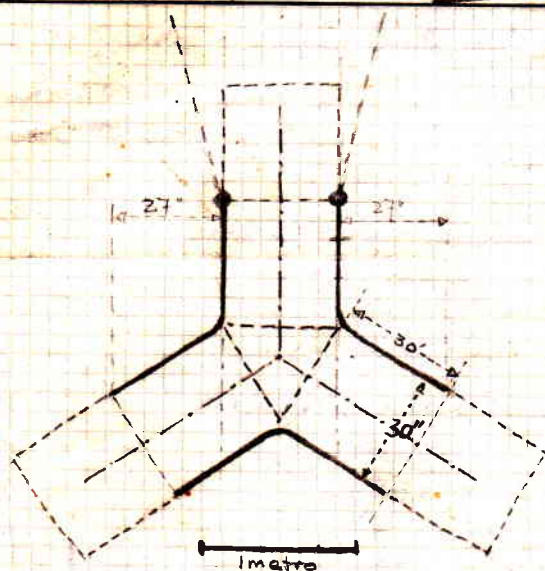
Assistant to the President

JD:fe

C O P Y

TELEGRAM FROM RIONE, MONTEVIDEO, DATED FEBRUARY 10, 1945, TO MR. REZZANO:

1. Cook pumps have cracks through all fixed blades about 1.5 thousandths wide extending inward 1/4 inch and maximum 7 inches long in a blade width of 14 inches or half way across the blade. We think these cracks are due to contractions due to cooling of the castings.
2. Moreover we have found voids in several parts of castings including the finished edges of the fixed parts at the impeller clearance.
3. Also find several main water passages partly closed by fins not removed from 3 to 4 square centimeters obstruction area.
4. The shaft is corroded for 3/4 of the length incorporated in the propeller. Therefore doubt that shaft is stainless steel as ordered.
5. The shaft of one pump has evidently been damaged in the factory and an effort made to cover it up by filing.
6. Have tested shaft for alignment and find several undulations.
7. One of the bearings has deep cracks.
8. We reject the both pumps and request immediate replacement with new ones without charge to Rione.
9. Manufacturer shall authorize operation of old pumps until replaced with new ones without obligation on part of Rione.
10. As soon as new pumps are in place will return old ones to factory.



Se toma una resistencia unitaria de 3000 $\Omega/\text{in.}^3$ resmeta: $\gamma = 3000$.

$$\frac{r \times 30}{30 \times x} I = 13,800 \quad / \quad I = 700 \text{ amp.}$$

$$x = \frac{3000 \times 30 \times 700}{30 \times 13,8 \times 10^3} = 152" = 3,87 \text{ mts}$$

Si se consideran 60" de ancho por fase resmeta $h = 76" = 1,93 \text{ auts.}$

Como condición del problema se establece que en el tail race pues un canal de 52 metros hoy 7 metros de agua y en consecuencia se pueden utilizar hasta 5 auts.

Peso aproximado:

$$180 \times 152 \times 6,5 \times 0,6 \times 7 = 750 \text{ kgs.}$$

Peso total aprox. 1500 kgs. para 10° de inclinación representan 250 kgs. (Empuje por 10° de inclinación).

Calentamiento del agua - con $V_0 = 2 \text{ mts/sq}$ Area = 3 mts^2

$$Q_a = 6 \text{ mts}^3/\text{sq} = 6000 \text{ lts/sq}$$

Mezcla airada por fase 11,000 KW sq = 2,8 KWH = 2,8 x 848 = 2370 cal.

$$\text{Elevación de temperatura 1º canal} = \frac{2370}{6000} = 0,4^\circ \text{C en los otros } 0,8^\circ \text{C}$$

Elevación de temperatura total = 1,2°C - ojo considerar porque el flujo de agua es menor evidentemente que el calculado.

Sección de salida del draft tube.

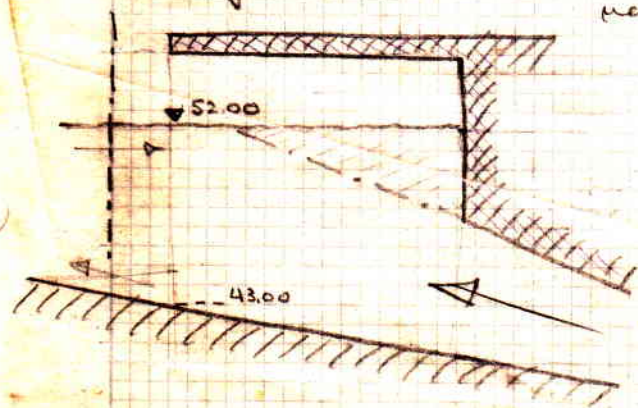
22,00 mts de ancho - Plena carga - cota 52 cota fondo 43 altura de agua 9 mts

Sección a plena carga 198 mts^2

Flujo de agua plena carga = 160 mts^3 Velocidad = $\frac{160}{198} = 0,8 \text{ mts/sq}$

Suponiendo en el water wheel un coeficiente de aprovechamiento de 0,8 (Bulhard) Tendría $V_0 = 0,8 \times 0,8 = 0,64$ y el calentamiento sería tres veces menor. 1,2°, 2,4° con un total de 3,6°C - para plena carga

Cargas bajas - Velocidad caerá mucho admitiendo el flujo de calificación por debajo.



Formula de la parte inferior de las placas -

Supongamos una profundidad mínima de inmersión de 10"
para tubos se tiene:

$$R = \frac{r}{2.73 \times l} \log \frac{2D}{d}$$

don D = distancia entre centros de tubos en pulgadas -

d = ϕ de tubos en pulgadas -

l = inmersión en pulgadas -

r = resistencia por piegada exterior -

Superficie mínima de electrodo sumergida $10 \times 10 = 100 \text{ in}^2$

$$R = \frac{8000}{2.73 \times 10} \log \frac{100}{8} \approx \frac{300}{2.73} = 110 \Omega \text{ estimados}$$

$$I = \frac{13,800}{190} = 73 \text{ A} \quad \text{carga} = 13.8 \times 73 = 950 \text{ kW.}$$

Es decir en total aprox. $\frac{1}{10}$ de carga -

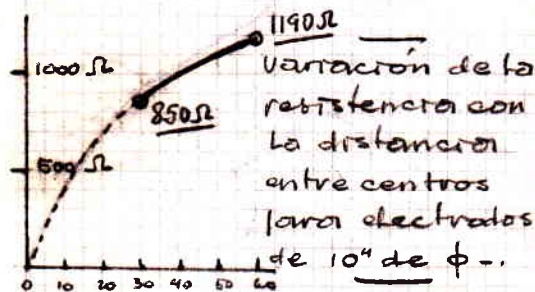
$$\text{Energía a disipar} \quad \frac{950}{3600} = 0.265 \text{ kWh.}$$

$$= 225 \text{ cal}$$

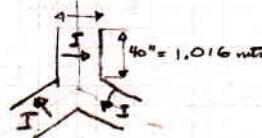
volumen en que se disipa $10 \times 10 \times 10 = 1000 \text{ cub. in.}$
de temperatura -

$$R = 1100 \log \frac{2D}{d}$$

D = 60	R = 1190
D = 50	R = 1100
D = 40	R = 1000
D = 30	R = 850



Placas de 80" (40 un lado)



Plena carga -
Espaciadas 30"

	inmersión	δ % en	
$r = 2000 \text{ } \Omega/\text{m}^3$	2.10 mtr - 0.230	} 760 amp.	
$r = 3000 \text{ } \Omega/\text{m}^3$	3.15 mtr - 0.152		
$r = 4000 \text{ } \Omega/\text{m}^3$	4.20 mtr - 0.115		
$r = 2000$	- 0.66 - 0.243	} 253 amp = $\frac{1}{3}$ carga	
$r = 3000$	- 1.00 - 0.163		
$r = 4000$	- 1.35 - 0.120		

Cargas bajas

Espaciadas 60"	δ % en	
$r = 2000$ - 1.40 - 0.11	} con 253 \times = $\frac{1}{3}$ carga	
$r = 3000$ - 2.10 - 0.077		
$r = 4000$ - 2.80 - 0.058		

Carga mínima para inmersión = 12"

$r = 2000$	$I = 55 \text{ amp.}$	$= 7\% \text{ carga}$	$\delta = 0.102$
$r = 3000$	$I = 37 \text{ amp}$	$= 5\% \text{ carga}$	$\delta = 0.077$
$r = 4000$	$I = 28 \text{ amp}$	$= 3.7\% \text{ carga}$	$\delta = 0.058$